PRIMARY PRODUCTIVITY OF COASTAL MARSHES IN MISSISSIPPI[1]

by

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ABSTRACT

The annual net primary production of nine types of marsh communities common in Mississippi Gulf Coast estuaries were studied by means of the Harvest Method. Production values ranged from 600 g m^{-2} yr^{-1} for a *Sagittaria lancifolia* marsh to 2330 g m^{-2} yr^{-1} for a *Phragmites communis* marsh. Primary productivity values for the other marsh types are *Juncus roemerianus* – 1697 g m^{-2} yr^{-1}, *Scirpus robustus* – 1056 g m^{-2} yr^{-1}, *Spartina cynosuroides* – 2190 g m^{-2} yr^{-1}, *Spartina patens* – 1922 g m^{-2} yr^{-1}, *Spartina alterniflora* tall form – 1964 g m^{-2} yr^{-1}, *S. alterniflora* short form – 1089 g m^{-2} yr^{-1}, and *Distichlis spicata* – 1484 g m^{-2} yr^{-1}. Annual net productivity in Mississippi marshes are generally slightly higher than those reported for the Atlantic marshes.

INTRODUCTION

Coastal marshes are commonly characterized as sites of extremely high primary production. Available data, however, are insufficient to support or refute such a generalization. It is more likely that marshes differ considerably in their productivity. The diverse nature of marshlands along the Gulf Coast of Mississippi offers an ideal opportunity to test differences in the primary productivity of different species of marsh plants. The marsh types described by Uhler and Hotchkiss (1968) as irregularly flooded marsh dominated by *J. roemerianus*, waterlogged salt flats of *D. spicata*, and salt meadows of *S. patens* are found in Mississippi coastal estuaries. Mixed stands of several marsh plant species are common. As many as 34 species may be found in one locality although only a few of these are of major importance (Gabriel and de la Cruz 1974).

Primary production studies in the northern Gulf of Mexico marshes are few. Kirby (1971) reported an annual net production of 1006–1410 g m^{-2} for an *S. alterniflora* marsh in Louisiana. Eleuterius (1972) estimated production value of about 2000 g m^{-2} yr^{-1} for a *J. roemerianus* marsh in Mississippi. More recently an initial study on a vegetationally mixed marsh at St. Louis Bay estuary in Mississippi showed production value of 1100 g m^{-2} yr^{-1} (Gabriel and de la Cruz 1974). In all these studies, only the annual net primary productivity of above ground materials was measured.

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MATERIALS AND METHODS

Monotypic stands of nine species of marsh plants were selected in the Gulf Coast of Mississippi (Fig. 1). *S. lancifolia* Pursh. (arrowhead) and *P. communis* Trinius. (common reed) were sampled along the terminal tributaries of Jourdan River about 3 km inland west of St. Louis Bay in Hancock County. This habitat is basically freshwater with salinities rarely exceeding 5 ‰ during flood tides. *J. roemerianus* Scheele (needlerush), *S. robustus* Pursh. (salt marsh bulrush), *S. cynosuroides* (L.) Roth. (giant cordgrass), and *S. patens* (Aiton) Muhl. (salt meadow cordgrass) were collected from St. Louis Bay estuary on a marsh island on the western side of the bay. The bay is a brackish water system with salinities ranging 2 ‰ to 12 ‰. *D. spicata* (L.) Greene (salt grass) and *S. alterniflora* Loisel (smooth cordgrass) were harvested from Bayou Casotte on the eastern section of the Mississippi coast in Jackson County a few kilometers from the Alabama state line. The *D. spicata* community is a waterlogged salt flat which was flooded during the entire period of the study; both short and tall forms of *S. alterniflora* are located along the eastern shore of the mouth of Bayou Casotte. This habitat is exposed to the inundation of saline water (>20 ‰) from Mississippi Sound.

Figure 1. The Mississippi Gulf Coast showing the location of (1) Jourdan River, (2) St. Louis Bay, and (3) Bayou Casotte marshes.

Three 1-square-meter plots were harvested monthly from each of the nine communities during the growing season (May to August 1973). The plants were clipped at the base about 2 cm above ground. Each m^2-plot sample was routinely examined for the presence of other species. Alive (i.e., green) plant parts were separated from the dead or brown biomass. Partially decaying plant tissues on the ground were gathered from each plot and thoroughly washed of mud. The decaying material was placed in a wire basket (5 mm mesh), washed by shaking the basket in the bay water, and rinsed in tap water in the laboratory. All plant materials were dried at 103°C for 24–48 hr. Annual net primary production of the above ground material (i.e., aerial parts) was estimated from the monthly increases during the growing season according to the procedure described by Milner and Hughes (1968) using the formula:

$$\text{Total annual primary aerial production } (g/m^2) = \Sigma_1^n (B_n - B_{n-1})$$

where B_n = biomass of nth sampling period (time t_n)

B_{n-1} = biomass of a previous sampling period (time t_{n-1})

Calorific values of samples of above ground plant material collected during the growing season were determined in an automatic Paar Adiabatic Bomb Calorimeter Model 1241 and production estimates were converted to ash-free kilocalories per square meter. Ash-free weight was determined by combustion at 550°C for 5 hr.

RESULTS AND DISCUSSION

Only two of the nine marsh communities studied were found in pure monotypic stands (Table 1). The seven species that appeared to be monotypic had a mixture of 1–22% of one or two other species. Compared to salt marshes in the south Atlantic coast, I observed that the Mississippi marshes are more dense and diverse; and are, in general slightly more productive.

The net aerial primary productivity of the marsh vegetations studied ranged from 600 g m^{-2} yr^{-1} for *S. lancifolia* to 2330 g m^{-2} yr^{-1} for *P. communis* (Table 2). Production value of 1697 g m^{-2} yr^{-1} for *J. roemerianus* is higher than previously reported in the literature (Williams and Murdoch 1972, Heald 1969, Stroud and Cooper 1968, Foster 1968, Waits 1967).

Net primary productivity of *S. alterniflora* short form (1089 g m^{-2} yr^{-1}) is higher than previously reported; the tall form productivity (1964 g m^{-2} yr^{-1}) is comparable to the values reported for Georgia and Louisiana (de la Cruz 1973, Keefe 1972). The values obtained for the other species are comparatively higher than the production values observed for similar and related species from other estuaries.

Caloric content of the plant species ranged from 4.46–4.75 Kcal/ash-free g (Table 3) and kilocalorie production of the marshes, ranges from 2468 Kcal M^{-2} yr^{-1} for *S. lancifolia* to 9841 Kcal m^{-2} yr^{-1} for *P. communis* (Table 2).

Table 1.

Vegetational Association of the Tidal Marsh Communities Studied on the Gulf Coast of Mississippi

Marsh Dominant Species	Percentage Composition of Minor Species					
	Sagittaria lancifolia	*Scirpus robustus*	*Juncus roemerianus*	*Spartina patens*	*Distichlis spicata*	*Cladium jamaicense*
Sagittaria lancifolia	...	...	2	22	...	...
Phragmites communis	9	...	...	...	...	0.5
Scirpus robustus	14	...	...	...	...	...
Juncus roemerianus	...	...	...	10	...	...
Spartina cynosuroides	...	4	...	...	1	...
Spartina patens	...	5	...	...	5	...
Distichlis spicata		Monotypic Stand				
Spartina alterniflora (tall)		Monotypic Stand				
Spartina alterniflora (short)	...	...	...	...	1	...

Table 2.

Annual Net Primary Productivity of Above Ground Materials of Various Marsh Communities in Mississippi Gulf Coast Estuaries

Marsh Community	Habitat Type	Geographic Location	Annual Net Primary Production dry g/m^2	$Kcal/m^2$*
Sagittaria lancifolia	Fresh	Jourdan River	600	2468
Phragmites communis	Fresh	Jourdan River	2330	9841
Scirpus robustus	Brackish	St. Louis Bay	1056	4576
Juncus roemerianus	Brackish	St. Louis Bay	1697	7558
Spartina cynosuroides	Brackish	St. Louis Bay	2190	9347
Spartina patens	Brackish	St. Louis Bay	1922	8464
Distichlis spicata	Brackish	Bayou Casotte	1484	6020
Spartina alterniflora (short form)	Saline	Bayou Casotte	1089	4028
Spartina alterniflora (tall form)	Saline	Bayou Casotte	1964	8088

*Ash-free basis.

The Mississippi tidal marshes are definitely more diverse (Gabriel and de la Cruz 1974) and are generally more productive than the marshes found in the Atlantic seaboard. The factors (e.g., soil types, tidal amplitude, and salinity regimes) that may influence the higher production values observed in the Mississippi marshes

Table 3.

Ash-free Weight and Caloric Content of Marsh Plants

Marsh Plants	No. Samples	Ash-free Dry Wt. (Per Cent) Mean Value	Coef. Var.	Caloric Content (Kcal/ash-free g) Mean Value	Coef. Var.
Sagittaria lancifolia	6	90.01	0.004	4.57	0.005
Phragmites communis	6	92.02	0.001	4.59	0.021
Scirpus robustus	6	93.40	0.003	4.64	0.011
*Juncus roemerianus**	16	94.96	0.007	4.69	0.009
*Spartina cynosuroides**	16	92.78	0.033	4.60	0.041
Spartina patens	6	92.71	0.009	4.75	0.008
*Distichlis spicata**	19	90.96	0.052	0.47	0.024
Spartina alterniflora (short)	6	82.01	0.007	4.51	0.003
Spartina alterniflora (tall)	6	88.18	0.005	4.67	0.017

*Data from Gabriel and de la Cruz 1974 (Literature Cited)

studied are currently under investigation. Kirby (1971) suggested that the greater productivity in the Gulf marshes may be partly due to the longer growing season in this geographic region. The significance of the high productivity of marshes in general has already been reviewed elsewhere (de la Cruz 1973).

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